DNP3.0 (Distributed Network Protocol)

for Acuvim II Series Power Meter

Structure Model

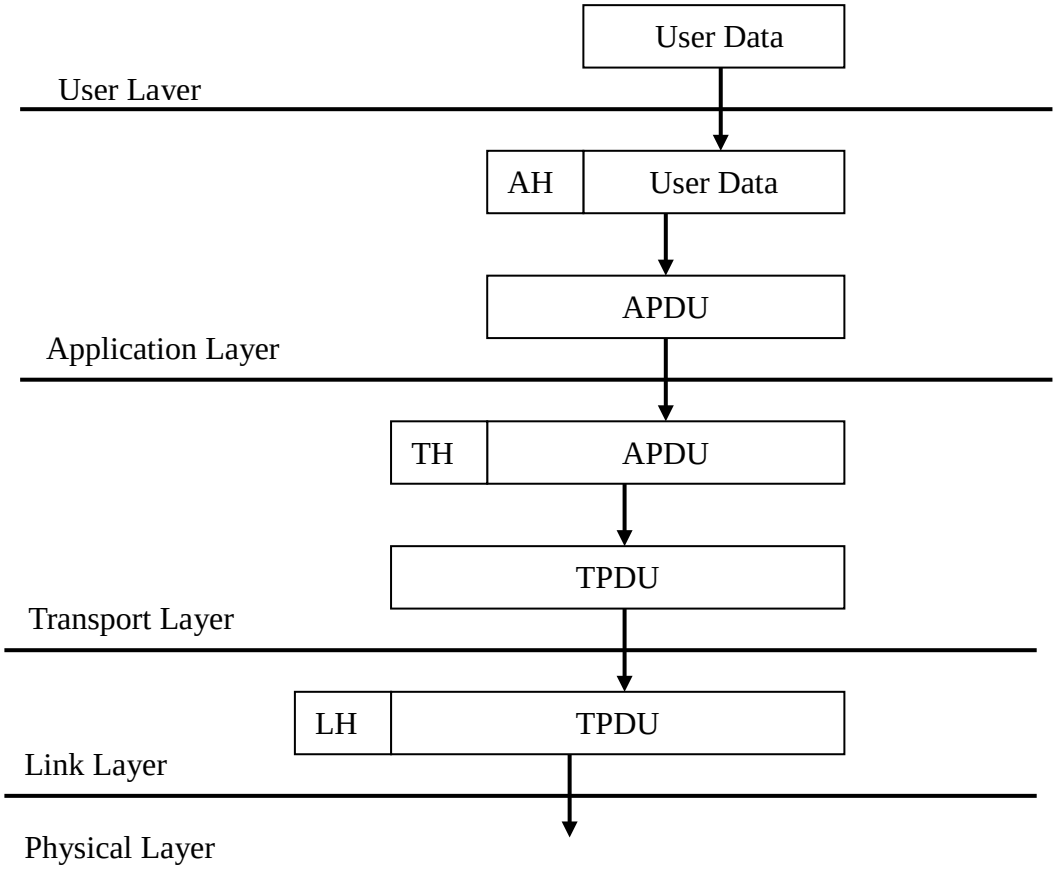


Figure 1 Each Layer of the relationship between the data unit

1 Overview

This document describes the DNP V3.00 communications protocol employed by Acuvim II Series Power Meter. This protocol can be selected for the serial communication port which can consist of RS232/RS485. It is assumed that the reader is familiar with the DNP V3.00 protocol and serial communications in general. This DNP3 is a reduced set of the Distributed Network Protocol Version 3.00, and it gives enough functionality to get critical measurement from the Acuvim II Series Power Meter. The DNP3 supports class0 object only. No event generation is supported .This DNP3 is always act as a slave device.

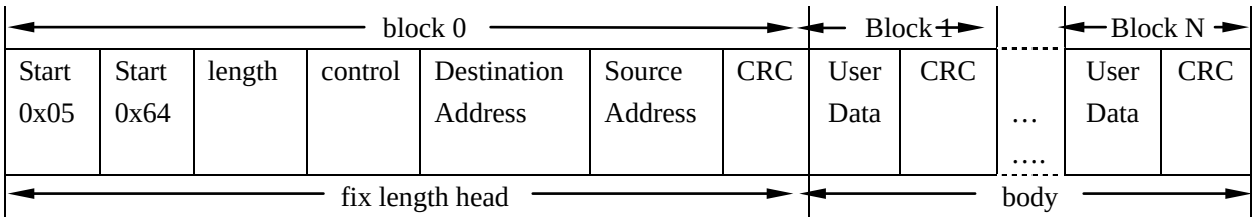
2 Physical Layer

The physical layer supported by DNP3 must transmit or receive data in serial mode. The data unit transferred will be 8 bits in length.
The port must be asynchronous half-duplex RS-485.
The data format supporting 8 bit data, 1 start bit, 1 stop bit, no parity.
The baud rate can be set to any supported value.

3 Data Link Layer

The Acuvim II Series Power Meter always acts as a Slave device .The device address can be set from 0 to 65534. The link layer comply with the stand FT3 frame format. The fixed length user data field is behind the fixed head. The link layer supports Reset Link, Reset User and Read Link Status. In order to ensure the stability of communication, it is recommended that you should better reset the link and reset the user before communicate with the Acuvim II Series Power Meter.
The function code supported as follows:
Reset Link (0X00), Reset User (0X01), Link Status (0X09).

FT3 Frame Format：
An FT3 frame is defined as a fixed length header block followed by optional data blocks. Each block has a 16-bit CRC appended to it. The header fields consist of 2 start octets, 1 octet length, 1 octet control, a destination address, a source address and a 16-bit CRC appended to it.



4 Transport Layer

The pseudo-transport layer segments application layer messages into multiple data link frames. For each frame, it inserts a single byte function code that indicates if the data link frame is the first frame of the message, the last frame of a message, or both (for single frame messages). The function code also includes a rolling frame sequence number which increments with each frame and allows the receiving transport layer to detect dropped frames.

5 Application Layer

The Acuvim II Series Power Meter implementation supports a subset of the objects and application layer function codes. The Acuvim II Series Power Meter will neither accept nor send multiple fragment application layer messages. The Acuvim II Series Power Meter’s fragment size is fixed at 2k bytes.

Each application layer fragment begins with an application layer header followed by one object header or object header and data combinations. The application layer header contains an application control code and an application function code. The application control code contains an indication if the fragment is one of a multi-fragment message, contains an indication if an application layer confirmation is requested for the fragment, contains an indication if the fragment was unsolicited, and contains a rolling application layer sequence number. The application layer sequence number allows the receiving application layer to detect fragments that are out of sequence, or dropped fragments.

In the Acuvim II Series Power Meter, the Dnp3 supports the **Read** function , the **Direct Operate** function and the **Direct Operate Unconfirmed** function.

- **The Read function (0X01)**

  The read function is the basic code used for requesting data objects from an Outstation. Here this function is used for reading the measurement data from the Power Meter. Learning more about the measurement data, please refer to the Data Address Table. In this function, the qualifier could be selected contain **0X00**, **0X01**, **0X06**.

  The qualifier **0X00** refers that there two bytes called Range followed by, one is the start address want to request, the second is the stop address, this Range would be from 0 to 255.

  The qualifier **0X01** indicates that the followed Range there are four bytes, the first two is the Start Address want to be request, the last two is the Stop Address, the two bytes consist of two 8-bit binary number , the low byte first, that the address Range would be from 0 to 65535.

  The qualifier **0X06** means read All data from the object with its respective variations which would be list in the queue.

  More about the message please see Message Layout, the detailed examples.

- **The Direct Operate function (0X05)**

  The function is selects and sets or operates the specified outputs, the status of the control points will be responded. Here this function is intended for resetting the energy counters and the demand counters. These actions are mapped to Objects 12 Variations 1, point 1 and point 2, there are seen as a control relay. The relay must be operated On in 0 millisecond , and released Off in 1 millisecond .The qualifiers 0X17 and 0X28 are supported for writing the energy reset and demand reset. The examples will be shown in Message Layout.

- **The Direct Operate function (0X06)**

  The function is selects and sets or operates the specified outputs but do not send a response to the request. Here this function is intended for switching the DNP3 protocol to Modbus protocol using the same communication port. This switching is seen as a control relay mapped into Object 12 Variation 1 and point 0 in the Acuvim II series Power Meter. The relay must be operated with qualifier 0X17, code 3, count 0, with 0 millisecond On and 1millisecond Off. After sending the request the current communication port will be changed to the Modbus protocol only. The example will be shown in the Message Layout.

6 Error Reply

When meet the can't recognize request , the unknown Object ,the unknown variation ,the point unsupported , the unsupported function code , the unsupported qualifier ,the unsupported range , the buffer overflow or any other exception error , an error reply will be generate from the Acuvim II series Power Meter to send to the requester station . The Internal Indicator field will reflect the type of error.

7 Profile

1) Device Function

Slave

2) Maximum Data Link Frame Size

Transmitted 292

Received 292

3) Maximum Application Fragment Size

Transmitted 2048

Received 2048

4) Transport Multi-Fragment

Supported

5) Data Link Layer Confirmation

Supported

6) Application Layer Confirmation

Supported

7) Application Layer Function

Request

Supported 0X01，Read

Qualifier，0X00,0X01,0X06.

Response

Supported 129，Read Response

Qualifier，0X00

Supported Error Internal Indicator Response

8) DATA OBJECT LIBRARY

a) ANALOG INPUT OBJECT 30

Variation: 3 ， 32-BIT ANALOG INPUT WITHOUT FLAG

Variation: 4 ， 16-BIT ANALOG INPUT WITHOUT FLAG

Variation 5 ， 32-BIT FLOAT WITH FLAG

b) COUNTER OBJECT DEFINITIONS 20

Variation: 5 ， 32-BIT COUNTER WITHOUT FLAG

c) ALTERNATE NUMERIC OBJECT 100

Variation: 1 ， SHORT FLOATING POINT

d) CONTROL RELAY OUTPUT BLOCK Object 12

Variation: 01 ， static digital output control

8 Data Address Table

Point Descriptions

The following tables describe the DNP V3.0 data objects provided by the Acuvim II series Power Meter. The object, variation, and point numbers are specified for each parameter, as well as the application layer function codes which may be used to operate on the parameter.

Description:

Object		Variation	32-BIT ANALOG INPUT WITHOUT FLAG
30		3	
Object		Variation	16-BIT ANALOG INPUT WITHOUT FLAG
30		4	
Object		Variation	32-BIT FLOAT INPUT WITH FLAG
30		5	
Object		Variation	32-BIT FLOAT INPUT WITH FLAG
100		1	
Object		Variation	32-BIT COUNTER WITHOUT FLAG
20		5	
Object		Variation	CONTROL RELAY OUTPUT BLOCK
12		1	

Address Table:

Object	Point	Variation	Name	Format	Range	Multiplier	Units	Descriptor
100	0	1	Freq_rms	FLOAT		1.0	Hz	Frequency
100	1	1	Ua_rms	FLOAT		1.0	V	Voltage A
100	2	1	Ub_rms	FLOAT		1.0	V	Voltage B
100	3	1	Uc_rms	FLOAT		1.0	V	Voltage C
100	4	1	Uvag_rms	FLOAT		1.0	V	Phrase Voltage Avg
100	5	1	Uab_rms	FLOAT		1.0	V	Voltage A-B
100	6	1	Ubc_rms	FLOAT		1.0	V	Voltage B-C
100	7	1	Uca_rms	FLOAT		1.0	V	Voltage C-A
100	8	1	Ulag_rms	FLOAT		1.0	A	Line Voltage Avg
100	9	1	Ia_rms	FLOAT		1.0	A	Current A
100	10	1	Ib_rms	FLOAT		1.0	A	Current B
100	11	1	Ic_rms	FLOAT		1.0	A	Current C
100	12	1	Ivag_rms	FLOAT		1.0	A	Current Average
100	13	1	In_rms	FLOAT		1.0	A	Neutral Current
100	14	1	Pa_rms	FLOAT		1.0	W	Pa
100	15	1	Pb_rms	FLOAT		1.0	W	Pb
100	16	1	Pc_rms	FLOAT		1.0	W	Pc
100	17	1	P_rms	FLOAT		1.0	W	Total Active Power
100	18	1	Qa_rms	FLOAT		1.0	var	Qa
100	19	1	Qb_rms	FLOAT		1.0	var	Qb
100	20	1	Qc_rms	FLOAT		1.0	var	Qc
100	21	1	Q_rms	FLOAT		1.0	var	Total Reactive Power
100	22	1	Sa_rms	FLOAT		1.0	VA	Sa
100	23	1	Sb_rms	FLOAT		1.0	VA	Sb
100	24	1	Sc_rms	FLOAT		1.0	VA	Sc
100	25	1	S_rms	FLOAT		1.0	VA	Total Apparent Power
100	26	1	PFa_rms	FLOAT		1.0	None	PFa
100	27	1	PFb_rms	FLOAT		1.0	None	PFb
100	28	1	PFc_rms	FLOAT		1.0	None	PFc
100	29	1	PF_rms	FLOAT		1.0	None	Total Power Factor
100	30	1	Unbl_u2	FLOAT		1.0	None	Voltage Imbalance
100	31	1	Unbl_i2	FLOAT		1.0	None	Current Imbanacne
100	32	1	Rlc_val	FLOAT		1.0	None	Load Characteristics
100	33	1	P_dema	FLOAT		1.0	W	P Demand
100	34	1	Q_dema	FLOAT		1.0	var	Q Demand
100	35	1	S_dema	FLOAT		1.0	VA	S Demand
100	36	1	Ia_Demand	FLOAT		1.0	A	Ia Demand
100	37	1	Ib_Demamd	FLOAT		1.0	A	Ib Demamd
100	38	1	Ic_Demand	FLOAT		1.0	A	Ic Demand

Object	Point	Variation	Name	Format	Range	Multiplier	Units	Descriptor
20	0	5	Active_Energy_IMP	UINT32	0-999999999	0.1/0.001	W hr	Active_Energy_ IMP
20	1	5	Active_Energy_EXP	UINT32	0-999999999	0.1/0.001	W hr	Active_Energy_EXP
20	2	5	Reactive_Energy_IMP	UINT32	0-999999999	0.1/0.001	var hr	Reactive_Energy_ IMP
20	3	5	Reactice_Energy_EXP	UINT32	0-999999999	0.1/0.001	var hr	Reactice_Energy_EXP
20	4	5	Active_Energy_TOTAL	UINT32	0-999999999	0.1/0.001	W hr	Active_Energy_TOTAL
20	5	5	Active_Energy_NET	UINT32	0-999999999	0.1/0.001	W hr	Active_Energy_NET
20	6	5	Reactive_Energy_TOTAL	UINT32	0-999999999	0.1/0.001	var hr	Reactive_EnergyTOTAL
20	7	5	Reactive_Energy_NET	UINT32	0-999999999	0.1/0.001	var hr	Reactive_Energy_NET
20	8	5	Apprent_Energy	UINT32	0-999999999	0.1/0.001	VA hr	Apprent_Energy
20	9	5	DI1Counts	UINT32	0-4294967259	1	None	DI1Counts
20	10	5	DI2Counts	UINT32	0-4294967259	1	None	DI2Counts
20	11	5	DI3Counts	UINT32	0-4294967259	1	None	DI3Counts
20	12	5	DI4Counts	UINT32	0-4294967259	1	None	DI4Counts
20	13	5	DI5Counts	UINT32	0-4294967259	1	None	DI5Counts
20	14	5	DI6Counts	UINT32	0-4294967259	1	None	DI6Counts
20	15	5	DI7Counts	UINT32	0-4294967259	1	None	DI7Counts
20	16	5	DI8Counts	UINT32	0-4294967259	1	None	DI8Counts
20	17	5	DI9Counts	UINT32	0-4294967259	1	None	DI9Counts
20	18	5	DI10Counts	UINT32	0-4294967259	1	None	DI10Counts
20	19	5	DI11Counts	UINT32	0-4294967259	1	None	DI11Counts
20	20	5	DI12Counts	UINT32	0-4294967259	1	None	DI12Counts
20	21	5	DI13Counts	UINT32	0-4294967259	1	None	DI13Counts
20	22	5	DI14Counts	UINT32	0-4294967259	1	None	DI14Counts
20	23	5	DI15Counts	UINT32	0-4294967259	1	None	DI15Counts
20	24	5	DI16Counts	UINT32	0-4294967259	1	None	DI16Counts
20	25	5	DI17Counts	UINT32	0-4294967259	1	None	DI17Counts
20	26	5	DI18Counts	UINT32	0-4294967259	1	None	DI18Counts
20	27	5	DI19Counts	UINT32	0-4294967259	1	None	DI19Counts
20	28	5	DI20Counts	UINT32	0-4294967259	1	None	DI20Counts
20	29	5	DI21Counts	UINT32	0-4294967259	1	None	DI21Counts
20	30	5	DI22Counts	UINT32	0-4294967259	1	None	DI22Counts
20	31	5	DI23Counts	UINT32	0-4294967259	1	None	DI23Counts
20	32	5	DI24Counts	UINT32	0-4294967259	1	None	DI24Counts
20	33	5	DI25Counts	UINT32	0-4294967259	1	None	DI25Counts
20	34	5	DI26Counts	UINT32	0-4294967259	1	None	DI26Counts
20	35	5	DI27Counts	UINT32	0-4294967259	1	None	DI27Counts
20	36	5	DI28Counts	UINT32	0-4294967259	1	None	DI28Counts

Object	Point	Variation	Name	Format	Range	Multiplier	Units	Descriptor
30	0	4	THD_V1	UINT16	0-10000	0.01	None	THD_V1
30	1	4	THD_V2	UINT16	0-10000	0.01	None	THD_V2
30	2	4	THD_V3	UINT16	0-10000	0.01	None	THD_V3
30	3	4	THD_V	UINT16	0-10000	0.01	None	THD_V
30	4	4	THD_ I1	UINT16	0-10000	0.01	None	THD_ I1
30	5	4	THD_ I2	UINT16	0-10000	0.01	None	THD_ I2
30	6	4	THD_ I3	UINT16	0-10000	0.01	None	THD_ I3
30	7	4	THD_I	UINT16	0-10000	0.01	None	THD_I

Object	Point	Variation	Name	Format	Range	Multiplier	Units	Descriptor
12	0	1	DNP3_MODBUS	None	1	1	None	Responds to Function 6 (Direct Operate - No Ack),Qualifier Code 17x,Control Code 3,Count 0, On 0 msec,Off 1 msec ONLY
12	1	1	Reset_Energy_Counters	None	1	1	None	Responds to Function 5 (Direct Operate)Qualifier Code 17x or 28x,Control Code 3,Count 0, On 0 msec,Off 1 msec ONLY
12	2	1	Reset_Demand_Counters	None	1	1	None	Responds to Function 5 (Direct Operate)Qualifier Code 17x or 28x,Control Code 3,Count 0, On 0 msec,Off 1 msec ONLY

9 DNP3 Message Layout

The following table is the abbreviation and explain.

DestL	The destination address low byte
DestH	The destination address high byte
SorcL	The source address low byte
SorcH	The source address high byte
CrcL	The Cyclic Redundancy Checksum low byte
CrcH	The Cyclic Redundancy Checksum high byte
x	The transport layer data sequence num
y	The application layer data sequence num
II1	The first byte of Internal Indicator
II2	The second byte of Internal Indicator

Link Layer Frames:

Reset Link:

Request	05	64	05	C0	DestL	DestH	SorcL	SorcH	CrcL	CrcH
Response	05	64	05	00	SorcL	SorcH	DestL	DestH	CrcL	CrcH

Reset User:

Request	05	64	05	C1	DestL	DestH	SorcL	SorcH	CrcL	CrcH
Response	05	64	05	00	SorcL	SorcH	DestL	DestH	CrcL	CrcH

Link Status:

Request	05	64	05	C9	DestL	DestH	SorcL	SorcH	CrcL	CrcH
Response	05	64	05	0B	SorcL	SorcH	DestL	DestH	CrcL	CrcH

Application Layer Frames:

Reset Energy:

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
Reset Energy																		
Request	05	64	18	C4	DestL	DestH	SorcL	SorcH	CrcL	CrcH								
	Cx	Cy	05	0C	01	17	01	01	03	00	00	00	00	00	01	00	CrcL	CrcH
	00	00	00	CrcL	CrcH													
Response	05	64	1A	44	SorcL	SorcH	DestL	DestH	CrcL	CrcH								
	Cx	Cy	81	II1	II2	0C	01	17	01	01	03	00	00	00	00	00	CrcL	CrcH
	01	00	00	00	00	CrcL	CrcH											
Request	05	64	1A	C4	DestL	DestH	SorcL	SorcH	CrcL	CrcH								
	Cx	Cy	05	0C	01	28	01	00	01	00	03	00	00	00	00	00	CrcL	CrcH
	01	00	00	00	00	CrcL	CrcH											
Response	05	64	1C	44	SorcL	SorcH	DestL	DestH	CrcL	CrcH								
	Cx	Cy	81	II1	II2	0C	01	28	01	00	01	00	03	00	00	00	CrcL	CrcH
	00	00	01	00	00	00	00	CrcL	CrcH									

Reset Demand:

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
Reset Demand																		
Request	05	64	18	C4	DestL	DestH	SorcL	SorcH	CrcL	CrcH								
	Cx	Cy	05	0C	01	17	01	02	03	00	00	00	00	00	01	00	CrcL	CrcH
	00	00	00	CrcL	CrcH													
Response	05	64	1A	44	SorcL	SorcH	DestL	DestH	CrcL	CrcH								
	Cx	Cy	81	II1	II2	0C	01	17	01	02	03	00	00	00	00	00	CrcL	CrcH
	01	00	00	00	00	CrcL	CrcH											
Request	05	64	1A	C4	DestL	DestH	SorcL	SorcH	CrcL	CrcH								
	Cx	Cy	05	0C	01	28	01	00	02	00	03	00	00	00	00	00	CrcL	CrcH
	01	00	00	00	00	CrcL	CrcH											
Response	05	64	1C	44	SorcL	SorcH	DestL	DestH	CrcL	CrcH								
	Cx	Cy	81	II1	II2	0C	01	28	01	00	02	00	03	00	00	00	CrcL	CrcH
	00	00	01	00	00	00	00	CrcL	CrcH									

Switch to Modbus:

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
Request	05	64	18	C4	DestL	DestH	SorcL	SorcH	CrcL	CrcH								
	Cx	Cy	06	0C	01	17	01	00	03	00	00	00	00	00	01	00	CrcL	CrcH
	00	00	00	CrcL	CrcH													

Request Data:

Qualifier 0X06:

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
Request Data	0X06																	
Request	05	64	0B	C4	DestL	DestH	SorcL	SorcH	CrcL	CrcH								
	Cx	Cy	01	1E	04	06	CrcL	CrcH										
Response	05	64	1F	44	SorcL	SorcH	DestL	DestH	CrcL	CrcH								
	Cx	Cy	81	II1	II2	1E	04	00	00	07	Data0 L	Data0 H	Data1 L	Data1 H	Data2 L	Data2 H	CrcL	CrcH
	Data3 L	Data3 H	Data4 L	Data4 H	Data5 L	Data5 H	Data6 L	Data6 H	Data7 L	Data7 H	CrcL	CrcH						

Qualifier 0X00:

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
Request Data	0X00																	
Request	05	64	0D	C4	DestL	DestH	SorcL	SorcH	CrcL	CrcH								
	Cx	Cy	01	64	01	00	03	07	CrcL	CrcH								
Response	05	64	28	44	SorcL	SorcH	DestL	DestH	CrcL	CrcH								
	Cx	Cy	81	II1	II2	64	01	00	03	07	Flag3	Data3 1	Data3 2	Data3 3	Data3 4	Flag4	CrcL	CrcH
	Data4 1	Data4 2	Data4 3	Data4 4	Flag5	Data5 1	Data5 2	Data5 3	Data5 4	Flag6	Data6 1	Data6 2	Data6 3	Data6 4	Flag7	Data7 1	CrcL	CrcH
	Data7 2	Data7 3	Data7 4	CrcL	CrcH													

Qualifier 0X00:

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
Request Data	0X00																	
Request	05	64	0D	C4	DestL	DestH	SorcL	SorcH	CrcL	CrcH								
	Cx	Cy	01	14	05	00	03	07	CrcL	CrcH								
Response	05	64	28	44	SorcL	SorcH	DestL	DestH	CrcL	CrcH								
	Cx	Cy	81	II1	II2	14	05	00	03	07	Data3 L	Data3 H	Data4 L	Data4 H	Data5 L	Data5 H	CrcL	CrcH
	Data6 L	Data6 H	Data7 L	Data7 H	CrcL	CrcH												

Qualifier 0X01:

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
Request Data	0X01																	
Request	05	64	0F	C4	DestL	DestH	SorcL	SorcH	CrcL	CrcH								
	Cx	Cy	01	14	05	01	00	00	0A	00	CrcL	CrcH						
Response	05	64	3D	44	SorcL	SorcH	DestL	DestH	CrcL	CrcH								
	Cx	Cy	81	II1	II2	14	05	01	00	00	0A	00	Data0 L	Data0 H	Data1 L	Data1 H	CrcL	CrcH
	Data2 L	Data2 H	Data3 L	Data3 H	Data4 L	Data4 H	Data5 L	Data5 H	Data6 L	Data6 H	Data7 L	Data7 H	Data8 L	Data8 H	Data9 L	Data9 H	CrcL	CrcH
	Data1 0L	Data1 0H	CrcL	CrcH														

Error Reply:

Error Reply										
Response	05	64	0A	44	DestL	DestH	SorcL	SorcH	CrcL	CrcH
	Cx	Cy	81	II1	II2	CrcL	CrcH			